EXHIBIT 3

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF OHIO

SARA HAWES, individually, and on behalf of all others similarly situated, Plaintiff, v. MACY'S WEST STORES, INC., Defendant.	Case No. 1:17-cv-00754 Judge Timothy S. Black

DECLARATION OF TUSHAR GHOSH

I, Tushar Ghosh, declare and state as follows:

1. I am over the age of 18 and under no disability. I have personal knowledge of the matters set forth herein, unless otherwise specifically indicated.

2. My name is Tushar Ghosh. I am the William A. Klopman Distinguished Professor of Textiles at the Wilson College of Textiles at North Carolina State University. I received my Ph.D. in Fiber and Polymer Science from North Carolina State University in 1987. I have been a member of the faculty at North Carolina State University since 1987. I have also served as a visiting Professor at the University of Sydney and the Indian Institute of Technology at Bombay.

3. In 2007, I received the Fiber Society's Founders Award for outstanding contributions to the science and technology of fibrous materials. My research activities are devoted to the technologies of fabric formation, mechanics of fiber assemblies and their characterization, and fiber-based structures for adaptive and responsive textiles.

4. I teach classes to both graduate students and undergraduates. The classes I have taught recently include courses on weaving technology, functional textiles, and characterization of textile materials.

5. I have been retained by counsel for AQ Textiles, LLC to provide analysis of issues related to thread count and composition of CVC sheets.

6. In connection with my work in this case, I generated a written report dated May 1, 2021. A true and accurate copy of that report, including all exhibits are attached to this Declaration as **Exhibit A**.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on May 3, 2021.

Tushar K. Ghosh

Tushar Ghosh, Ph.D.

EXHIBIT A

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF OHIO

SARA HAWES, individually, and on behalf of all others similarly situated, Plaintiff, v. MACY'S WEST STORES, INC., Defendant.	Case No. 1:17-cv-00754 Judge Timothy S. Black

EXPERT REPORT OF TUSHAR GHOSH, Ph.D.

May 1, 2021

I. Background and Task

1. My name is Tushar K. Ghosh. I am currently the William A. Klopman Distinguished Professor of Textiles at the Wilson College of Textiles, North Carolina State University in Raleigh, NC.

2. My educational background covers a broad area of Fiber Science & Textile Technology. My areas of academic interests include the formation of textile structures, mechanics of fiber assemblies, characterization of fibrous materials, design and development of functional fibers, and fiber-based structures for adaptive and responsive textiles. In recent times I have been engaged in research in the fabrication of sensors and actuators involving polymer nanocomposites, electroactive polymers, artificial muscles, and biomimetic systems. I have been teaching courses on Technology of Weaving, Characterization of Textiles, and Technical Textiles at both graduate and undergraduate levels. A copy of my curriculum vitae, including a list of my publications, is attached as **Exhibit 1**.

3. I have not testified by deposition or at trial in the last four years.

4. I have been retained by counsel for Defendant Macy's West Stores, Inc. ("MWSI"). My rate for this matter is $300 per hour and $3,000 per day if required to travel. To date, my fee for completing this work is approximately $ 13,000.

5. In informing my opinion, I have reviewed, among other things, the Third Amended Complaint, the Report of Sean Cormier, deposition transcripts, and other documents provided to me by counsel for MWSI. A complete list of the documents I have considered is attached as **Exhibit 2**. Additionally, I had an interview with employees[1] of Creative Textiles about the manufacturing process they use to make bedsheets sold to AQ Textiles.

[1] Vijay Agrawal, Saching Kulkarni, and Parag Tejani.

6. I have also examined four sets of sheets including one set (Somerset) that I understand is the set Plaintiff claims to have purchased, which was provided by Mr. Cormier, and three sets (Optimal Performance, Fairfield Square, and Camden) of sheets provided by Macy's counsel, which are the same products referenced by Mr. Cormier as ones he purchased to test.

II. Plaintiff's Contentions

7. After reviewing the Third Amended Complaint and Cormier Report, I believe the main issues of contention, in this case, are the following;

8. **[Contention 1]** The sheets sold by Macy's and supplied by AQ Textiles do not have the thread counts represented by Macy's on the marketing and labeling of the products and that the thread counts are much lower.

9. **[Contention 2]** The supposed alternative method used by Creative Textiles and AQ Textiles to count the number of threads in the bedsheet is wrong and does not follow the methods suggested by ASTM D3775-03 (Updated version is ASTM D3775-17).

10. **[Contention 3]** Lastly, the consumers buy bedsheets of higher thread count because they are of better quality, more durable, softer, and/or better for sleeping than those with lower thread count. (Or simply stated, "High thread count bed sheets are of better quality.")

11. I plan to address each of these contentions in the following section after a brief review of the relevant technologies and terminologies.

III. Basis for Opinions

12. Based on my work on this case to date, this report contains a complete statement of the opinions I intend to provide in this matter. If additional evidence is uncovered or if Plaintiff's expert provides additional information or opinions, I will respond if asked. My opinions on these issues are based on my research, academic, and industrial experience over the last 45 years. Over

these years I have taught courses on the technology of textile manufacturing (e.g. ring spinning, weaving, etc.) and products as well as their characterization regularly. Before I offer my opinion on the allegations, I believe it is essential to understand the basic terms and technologies that are common to all woven textile products and the specific technology involved in the weaving of the subject product(s) as generally described in the US Patent 9,131,790. The structural design of textiles for a specific application requirement(s) is a complex process of optimization. Design, manufacturing technologies, as well as material properties, determine the structural and eventual performance of the products. In the process I also plan to define the common terminologies for easier understanding of the discussions that follow;

Relevant Textile Terms and Definitions

13. Terminologies used in textiles have evolved over thousands of years sometimes they are regional and often contextual. In light of some of the erroneous and misleading comments (*cf*. Section V) made by the plaintiff's expert, it is important to define the terms clearly, using reliable sources before launching into the discussion of the facts in this case. The definitions presented below are cited from two sources, the Standard Terminology Relating to Textiles (D123-19) published by ASTM International (ASTM), and the Textile Institute's (TI) Textile Terms and Definitions[2]. In some instances, the emphasis is added to indicate their particular relevance to this case.

Fiber: A generic term for any one of the various types of matter that form the basic elements of a textile and that is characterized by having a length at least 100 times its diameter. [ASTM]

[2] Textile Terms and Definitions, 8th ed. (1986), The Textile Institute, ISBN 0 900739 82 7

A unit of matter characterized by flexibility, fineness, and a high ratio of length to thickness. [TI]

Monofilament: <u>a single filament which can function as a yarn</u> in commercial textile operations, that is, it must be strong and flexible enough to be knitted, woven, or braided, etc. [ASTM]

(TI lists monofilament as "monofilament yarn" and refers the reader to "see continuous-filament yarn".)

Yarn: A generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric.[ASTM]

A product of substantial length and relatively small cross-section consisting of fibers and/or filament(s) with or without twist. <u>(Note 2: Staple, continuous filament, and monofilament yarns are included, Note 4: Zero twist continuous filament yarns are included)</u> [TI]

Continuous Filament Yarns: a yarn made of filaments that extend substantially throughout the length of the yarn. [ASTM]

<u>A yarn composed of one or more filaments that run essentially the whole length of the yarn.</u> (Note: Yarns of one or more filaments are usually referred to as monofilament and multifilament, respectively.) [TI]

Single yarn: the simplest strand of textile material suitable for operations such as weaving, knitting, etc.

Plied yarn: An alternative to the term folded yarn (TI)

Folded Yarn; doubled yarn; **plied yarn**: A yarn in which two or more single yarns are twisted together in one operation, e.g., two-fold yarn, three-fold yarn, etc. [TI]

Pick: (1) A single operation of the weft-inserting mechanism in weaving. (2) A single weft thread in a fabric as woven. <u>Note: A single picking operation in weaving may insert more than one pick (i.e., weft thread) in the fabric.</u> [TI]

Pick count: in woven fabrics, the number of individual filling yarns per inch of fabric regardless of whether they are comprised of single or piled components.

Pick, dead; crammed pick: <u>A pick on which the take-up motion is put out of action.</u> [TI]

Thread Count: in woven textiles as used in sheets and bedding, the sum of the number of warp yarns (ends) and filling yarns (picks) per unit distance as counted while the fabric is held under zero tension and is free of folds and wrinkles, individual warp and filling yarns are counted as single units regardless of whether comprised of single or plied components. [ASTM]

Denier: the unit of linear density, equal to the mass in grams of 9000 m of fiber, yarn, or other textile strand that is used in a direct yarn numbering system. [ASTM]

<u>Woven Fabric and Weaving Technology: A Brief Overview</u>

14. A woven fabric **(Figure 1)** is a planar structure consisting of two sets of yarns, warp, and weft (fill), interlaced perpendicularly to each other. ***<u>Warp</u>*** yarns lie along the length of the fabric. The single warp yarn is called an ***<u>end</u>***. ***<u>Filling</u>*** yarns lie normal to the warp direction, along the width of the fabric, a single filling yarn is called a ***<u>pick</u>***.

15. Weaving is a very old art that has evolved into a productive, complex, and versatile technology. Yet, the fundamental underlying principle of weaving has remained essentially the same for more than 6000 years.[3]

[3] Leslie Eadie and Tushar K. Ghosh, J. R. Soc. Interface (2011) 8, 761–775 doi:10.1098/rsif.2010.0487

16. Weaving is a process of *interlacing* two sets of yarns, perpendicular to each other, called ***warp*** and ***weft*** (or ***filling***), see **Figure 2**. The order of interlacement is determined by the *fabric design*. Before the actual weaving process, the warp yarn is prepared using multiple steps (winding, warping, sizing, etc.). The product of the warp ***yarn preparation*** is a yarn package called ***weaver's beam***, in which thousands of yarns are assembled parallel to each other. In the last step of the warp yarn preparation, these warp yarns are individually drawn through various machine components including the ***heddles*** (often mounted on a harness frame) to facilitate control of these yarns during weaving. While each warp yarn (also called an ***end***) is drawn through a hole in a **heddle**, these heddles are separated into groups of two or more and mounted on ***harnesses*** **or** ***harness frames***.

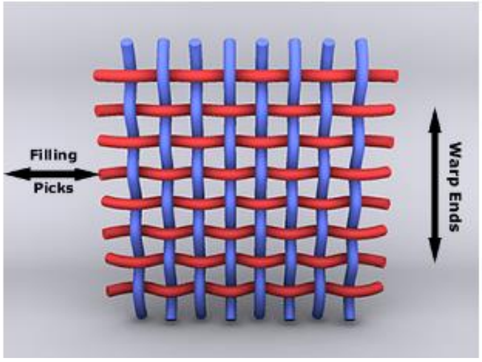


Figure 1: Plan view of the simple woven fabric.

17. During the weaving process, several motions or mechanisms are activated **in sequence** over ***one weaving cycle*** (discussed in more detail later) to insert one filling yarn into the warp. These mechanisms are ***shedding***, ***filling insertion***, ***beat-up, and fabric take-up & warp let-off***.

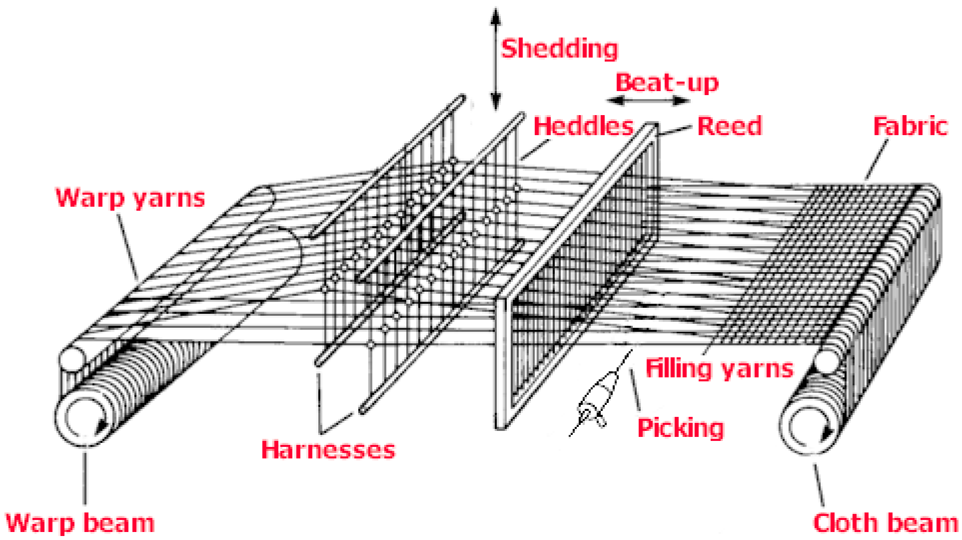


Figure 2 Schematic of a weaving machine

18. In shedding, the warp yarns are opened up in two sections to form a ***shed***, an interlacing path, for the filling yarn, see Figure 2.

19. Once a shed is formed, the ***filling insertion*** mechanism is activated to insert a filling yarn through the shed, see Figure 2. In this process, a discrete length of yarn is taken from an external filling yarn supply package and is propelled through the shed utilizing a fluid jet (air or water), or a projectile, or one or two rapiers (a rapier is a thin rod with a yarn clamp or gripper at one end).

20. Following the filling insertion, (the shed may or may not close/change), in a ***beat-up***, the filling yarn just inserted is pushed close to the last filling yarn using a comb-like device called a ***reed***. Just about the same time, the fabric take-up winds the length of fabric (just woven) same as the ***pick-spacing*** on the cloth roll, and the warp let-off releases the required length of the warp. This completes the ***weaving cycle***. The density of picks (proximity of the filling yarns) most commonly described as the ***number of picks per***

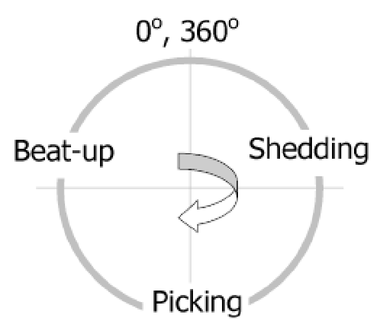


Figure 3. It takes one weaving cycle to insert one pick

inch is controlled by the take-up mechanism. This sequence of events completes the ***weaving cycle***. Figure 3 represents the schematic of the weaving cycle.

21. A weaving machine of today is capable of completing 300-2000 weaving cycles per minute, depending on the technology and product/raw material type. The primary limitation of this age-old technology, based on sequential completion of events (or activation of mechanisms), has always been that **one weaving cycle corresponds to the insertion of one pick**. This severely limits the productivity of a weaving machine, typically measured in length of fabric produced per unit time (e.g. m/hour).

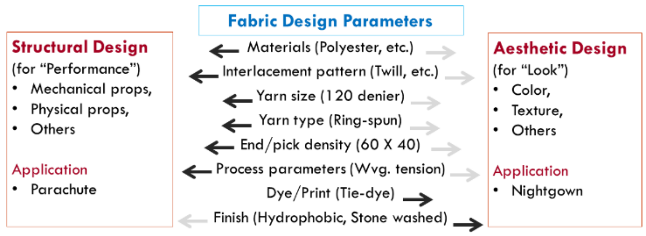
22. Efforts to overcome this limitation have primarily been directed toward the development of ***multiphase weaving technologies***[4] that involve the simultaneous insertion of multiple picks. Theoretically, this approach should allow a multi-fold increase in productivity. However, commercial success has been spotty because of the complexity of the processes and limited design capability. The technology used to manufacture the sheets that are at issue in this litigation, as described in the **U.S. patent 9,131,790** addresses this issue of productivity in a very limited manner.[5]

[4] K.L. Gandhi, The fundamentals of weaving technology, Editor(s): K.L. Gandhi, In The Textile Institute Book Series, Woven Textiles (Second Edition), Woodhead Publishing, 2020, Pages 167-270.

[5] Agarwal, A. (2015), PROLIFERATED THREAD COUNT OF A WOVEN TEXTILE BY SIMULTANEOUS INSERTON WITHNA SINGLE PICK INSERTON EVENT OF A LOOMAPPARATUS MULTIPLE ADJACENT PARALLELYARNS DRAWN FROMA MULT-PCK YARN PACKAGE (US 9,131,790 B2), U.S. Patent and Trademark Office.

Fabric Design

Table 1. Complexity of fabric design



23. The process of fabric design for a given application, in a broad sense, involves many parameters (see Table 1). In the context of this lawsuit, two parameters are relevant, namely the ***interlacement pattern*** and ***end/pick density***. The yarn interlacement pattern generally refers to the up and down position of an individual warp yarn with respect to the filling yarns (or vice versa). This in turn is controlled by the up or down positioning of the harnesses to form a shed before the filling insertion. For instance, the example of interlacement shown in **Figure 4a** shows warp yarn numbers 1 and 2 are going over and under filling yarn number 1, respectively, and subsequently over and under alternating filling yarns. This interlacement, called ***plain weave***, is implemented by inserting one filling yarn or pick in a shed formed in one weaving cycle. In another design, called ***warp rib*** multiple picks are inserted in the same shed opened during three weaving cycles, see **Figure 4b**. It is important to note that in the typical weaving process every pick in this design (and others) is inserted in separate weaving cycles even when they are being inserted in the same shed, and thereby severely limiting the productivity of a weaving machine. This is what is addressed in U.S. patent 9,131,790.

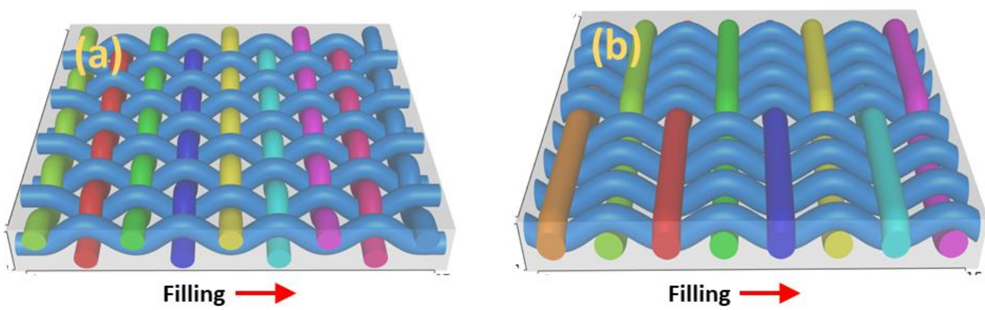


Figure 4. Three-dimensional view of two weave designs, (a) plain weave, (b) 4x4 warp rib weave

Comments on US Patent 9, 131, 790

24. U.S. patent 9,131,790, or "the '790 patent" describes how to simultaneously insert multiple adjacent parallel yarns within a single pick. The patent describes the texturing (false-twist) and winding of **"Multi-pick" filling yarn packages** as part of the filling yarn preparation as well as the use of these packages to supply filling yarns in a weaving machine.

25. In the multi-pick filling yarn package described in the '790 patent, individual polyester yarns removed from separate yarn packages are textured and intermingled, individually, for bulk and coherence before being assembled side by side (or in parallel) and wound on a take-up package. The winding process does not employ any assembly twist or intermingling.

26. In the weaving process, the filling yarns coming from one or more of the multi-pick filling yarn packages are fed to the filling insertion mechanism of a loom to weave fabrics having " 90 to 235 ends per inch warp yarns and from 100-765 picks per inch multi-filament polyester weft yarns."

27. Using the methods described in this patent, it is possible to insert multiple picks in the same shed in one weaving cycle. For example, to weave the design shown in **Figure 4b**, all of the picks inserted in the same shed can be inserted in a single weaving cycle. Therefore, the design described in **Figure 4b** can be woven at a speed four times higher than the common practice.

28. From my conversations with employees of Creative Textiles, it is my understanding that the CVC sheets manufactured by Creative, imported by AQ, and sold to Macy's (which are at issue in this lawsuit) were manufactured using this process.

IV. Opinions

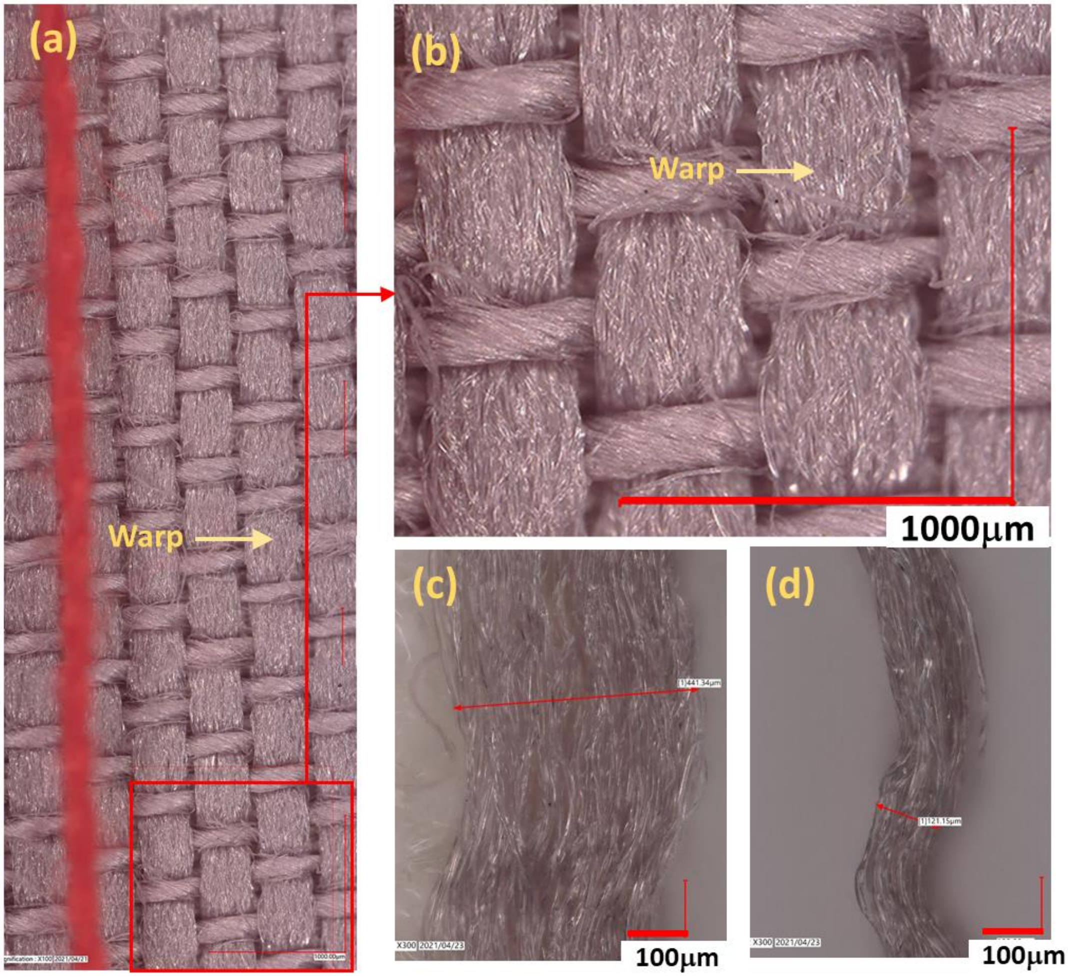
If called upon to testify in this matter, I would offer the following opinions in response to Plaintiff's contentions identified above.

29. **[Contention 1]** The sheets sold by Macy's and supplied by AQ Textiles do not have the thread counts represented by Macy's on the marketing and labeling of the products and that the thread counts are much lower.

After examining relevant documents (including deposition transcripts, the '790 patent, test reports, and the products analyzed by Plaintiff's expert, Sean Cormier), I believe the thread counts calculated by Mr. Cormier are incorrect. While there is no debate about the number of ends in the products, the allegation about the thread count stems from the misinterpretation of the number of picks per inch of the bedsheets.

The fabrics in question are constructed of staple fiber yarns in the warp direction and zero-twist continuous filament yarns in the filling direction. Understandably, a superficial examination of the fabric might produce an erroneous count of the picks per inch as reported by the plaintiff's expert Mr. Cormier. The fabrics in question, however, are produced using the technology described in **<u>US Patent 9, 131, 790</u>** (henceforth called multi-pick technology). For example, one set of specifications for the 900 TC Somerset by AQ Textiles has 185 ends/inch of 60's cotton count warp yarn and 69 insertions of 10 picks/insertion (OR 690 picks/inch) of 15 denier polyester continuous filament yarns, each having 8 filaments. In other words, a cursory examination of the fabric may suggest that the fabric has 185 ends/inch and 69 pick insertions/inch.

Figure 5 Optical micrographs of fabric 900 TC Somerset by AQ Textiles, (a) montage of planar views to show the absence of twist in the filling yarn, (b) magnified view of part of image (a), (c) Top view of a filling yarn in the fabric, (d) side view of the filing yarn in image (c). In Images a and b the arrows point to the warp direction.



However, a closer examination (like the one I performed) yields a significant difference between the fabric structures produced by a traditional one-pick/weaving cycle (or insertion) and the multipack technologies, and hence the real number of picks/inch. Figure 5 shows various low magnification optical micrographs of the same fabric. The planar view in Figure 5a shows the twisted staple fiber yarns of (almost) cylindrical shape in the warp direction, whereas the filling direction shows the ribbon-shaped bundle of polyester continuous filament yarns. **<u>This observation, further validated in the planar and side views of the weft yarns presented in Figure 5c and d, is the key to understanding the unique structure.</u>** The planar and side views of the filling yarns demonstrating a ribbon-like cross-section are due to the side-by-side assembly

of ten filling yarns of 15/8/0 (denier/no. of filaments/twist) before insertion in the same shed. This construction, observed in the images in Figure 5, is exactly what is described in the '790 patent as the multi-pick technology. While the ribbon-like filling yarn bundle inserted together in one filling insertion has mostly survived the subsequent processes of dyeing and finishing, the boundaries of these yarns are unclear in the images because of the expected filament migration from one to the other in the absence of twist. On the other hand, if the filling yarns were a 10-ply yarn having an assembly twist, it would have appeared in a more circular cross-section shape. **In counting the number of picks per inch, one should therefore count all of the yarns included in the ribbon-like bundle.** Mr. Cormier failed to do so, and his thread counts are therefore incorrect.

30. **[Contention 2]** The alleged alternative method used by the manufacturer and AQ Textiles to count the number of threads in the bedsheet is wrong and does not follow the methods suggested by the Standards, in specific ASTM D3775-03 (Updated version is ASTM D3775-17).

The many critical comments made in the Third Amended Complaint as well as by the plaintiff's expert, Mr. Cormier, in his report and deposition on the methods used by AQ Textiles to count the number of threads in the bedsheet, is unwarranted, pointless, and without merit. The complaint repeatedly refers to a part of the Procedure 9.1.1 in the ASTM Standard D3775-03, *". . Count individual warp yarns (ends) and filling yarns (picks) as single units regardless of whether they are comprised of single or plied components."* Applying that language here means counting every individual weft yarn (pick). If Cormier's interpretation of the ASTM D3775 procedure is that any number of picks inserted in one shed should be counted as only one pick, that is incorrect. It is not the case that the multi-pick technology used in the manufacture of the products I reviewed inserts a plied yarn in a single insertion; that is a misunderstanding of the manufacturing method

and the resulting fabric structure. A plied yarn requires some level of assembly twist (refer to the definition earlier) and there is no twist in the ribbon-like multi-pick bundle inserted in the fabric. This particular procedural point does not even appear in the latest version of the ASTM standard (D3775-17). Procedure 9.1.3 in ASTM D3775-17 clearly states, *"When two yarns are laid-in together and parallel, count each yarn separately, as a single unit, regardless of whether it is comprised of single or plied components."* This part of the procedure is most pertinent to the multi-pick technology presented in patent '790 earlier. The pointed tool or needle used to separate the individual yarns from the parallel bundle for counting is also clearly within the scope of the standard method and described in the section Apparatus, "6.1 Use any suitable device, such as pick glass, rule and pointer, microfilm reader, or projection equipment."

31. **[Contention 3]** Lastly, it is asserted that the consumers buy bedsheets of higher thread count because they are of better quality, more durable, softer, and/or better for sleeping than those with lower thread count. (Or simply stated, "High thread count bed sheets are of better quality.")

I have not conducted any consumer studies, which would be necessary to truly judge why any given consumer buys a bedsheet; presumably, they do so for all sorts of reasons. But in my opinion, this assertion is born out of a simplistic understanding of textiles and their structure-performance relationship. Higher thread count (and by implication lots of finer yarns jammed into a small space) does not necessarily produce bedding of "higher quality, durability, longevity, softer, and/or better for sleeping than lower thread count bedding." In fact, for specified fiber material, a fabric made out of densely packed (more numbers per unit length) fine yarns is more likely to be stiff, crisp, and more paper-like. The reason is simple, the softness of a textile structure is derived from the ability of its constituents (yarns or fibers) to move and allow deformation. In a

densely packed structure that becomes more difficult. This clear difference is seen in the characteristics of a film and a fabric. The voids and discontinuities accommodate applied deformation with relatively little resistance. For the same reason, a twisted structure is generally stiffer than a similar untwisted structure.

V. The Numerous Erroneous and Misleading Comments by Mr. Cormier

32. The expert opinions offered by Mr. Cormier in his report and deposition are strewn with inaccuracies and misstatements. It is important to point some of these out for the sake of proper contextualization of the facts in this case.

A. Errors Regarding Basic Textile Terms and Principles

First, Mr. Cormier makes many simple errors with respect to the terminology and fundamental principles involved in weaving textile products. These errors contribute to his incorrect conclusions regarding the products at issue.

"Polyester uses the denier system that uses the formula of 9,000 meters of yarn per one gram. Therefore, a size 20 Denier fiber is 1800 meters of yarn weighing one gram." [Report, P8]

33. This explanation of denier is completely wrong. Denier is one of the units of fiber/yarn mass linear density. The definition is simple and it is the weight in grams of 9000 meters of fiber or yarn. The tortuous explanation provided by Mr. Cormier in the second sentence is also erroneous; 9000 meters of a 20 denier fiber should weigh 20 grams and 1800 meters of it should weigh 4 grams, where does one gram come from?

"Q. So if it was a hundred grams for 9,000 yarns, that would be a hundred denier?

A. Well, I generally go back the other way. So if it's 9,000 weighing one gram, 900 would be a 10 denier, 90 would be a hundred denier." [Dep, P96-97]

34. This dialogue demonstrates a deep lack of understanding of the fundamentals of textile terms and units of measure. Here, Mr. Cormier is given repeated opportunities to correct

himself. Instead of recognizing the mistakes, He responds with the line "*Well, I generally go back the other way. So if it's 9,000 weighing one gram, 900 would be a 10 denier, 90 would be a hundred denier.*" Once again, it's a meaningless, confusing interpretation of a simple concept of denier.

"The polyester fibers are very fine, and the fiber itself is not suitable for production, as it is too weak. The fibers are thus combined together to form a yarn, and the yarn, consisting of multiple fibers/strands, is now ready for use as a building block to make fabrics."[Report, P8]

35. This is one of the simplistic and misleading comments in the report. The fineness of the commonly available commercial polyester fibers is in the range of 10-200 microns and their strength varies between 5-10 grams per denier.[6] Polyester fibers are considered one of the strongest of the common fibers and are generally stronger than cotton, wool, silk, rayon, and nylon fibers [5]. Polyester monofilaments are used in making many technical textile products. The staple (short lengths of ~1 inch) or continuous filaments of polyester fibers are combined to form a yarn not just for strength but more importantly to make a continuous strand (in case of staples) as well as a yarn that is suitable for the intended application in terms of other properties such as bulk, flexibility, etc.

"Yarns are made from fibers, and it takes as many as 10 or 12 polyester FIBERS to make the yarn." [Report, P14]

36. The statement is misleading at best. According to any definition of yarn, it could be made of one or more fibers, depending on the need.

"Further, in an email dated 4/27/2017, AQ states "the standard does not distinguish between cotton and Polyester fibers. Threads are threads and could be cotton or polyester." But this is clearly not true. If one was to untwist a cotton yarn one would have thousands of individual cotton fibers and this simply could not be counted." [Report, P14]

[6] Tatsuya Hongu, Glyn O. Phillips, Machiko Takigami, Superfibers, Editor(s): Tatsuya Hongu, lyn O. Phillips, Machiko Takigami, In Woodhead Publishing Series in Textiles, New Millennium Fibers, Woodhead Publishing, 2005, Pages 65-98; Warner, S., Fiber Science, Prentice Hall (1995), ISBN 0-02-424541-0.

37. Anyone with a rudimentary knowledge of textiles would agree with the statement that Cormier attributed to AQ Textiles. What part of it is wrong? Cotton is available only as staple fibers and a staple fiber is not a yarn (or a thread) until these fibers are twisted together to form a continuous strand. In the absence of a twist, there is no yarn. The same would happen to a yarn made of any staple fibers of polyester and/or other fibers. In contrast, a continuous filament of any kind (polyester, nylon, silk, etc.) could form a yarn (see definitions) with or without a twist. Therefore in counting the number of ends or picks per inch the type of fiber is immaterial.

"Q. Is it your testimony that those are the three types of weave in fabric and any other type is a subtype of one of those three?
A. Yes." [Dep, P15]

38. Contrary to this assertion, there are almost infinite varieties of weave designs.

"Q. Sir, are either of those definitions definitions that you're familiar with?
A. I call them -- the ravel, I would call a reed. And really the reed is where you would put the individual yarns through so that you can control the up and down motion. As I said, in a plain weave, where you could have over-under, so I call it the reed." [Dep, P105]

39. This exchange in a way demonstrates a lack of understanding of the weaving technology for textile manufacturing on Mr. Cormier's part. The reed has nothing to do with controlling the up and down motion of the yarns. He is confusing harnesses with the reed.

B. <u>Errors in Mr. Cormier's Analysis and Conclusions</u>

Second, Mr. Cormier makes several errors directly related to his analysis and evaluation of the products at issue. Those errors, along with the other issues discussed in the following, make his opinions deeply flawed.

". . . consumers purchase the products reasonably believing that they were purchasing a product with the stated thread count and which is of higher quality, durability, longevity, and/or softness, and/or better for sleeping, than products with a lower thread count." [Report, P4]

40. There is no rational scientific reason for this belief. In science, assertions of these kinds require supportive and meaningful discussion or evidence in the form of citations. In the absence of that, it's simply speculation. Textiles made of higher thread count are almost certainly thinner, less permeable, and stiffer. While subjective characteristics such as quality, durability, and longevity are application-specific and as such have little to do with higher thread count, attributes of softness and "better sleeping" are very likely to be harmed by higher thread count. For reasons explained earlier, a higher thread count is likely to produce relatively stiffer and crisper fabric. The softness of a fabric depends on many of its mechanical properties, the most important among them are lower stiffness in compression and bending.

"Not one of the tools allows you to untwist the yarns and count the fibers because that is not the way to count yarns."[Report, P13]

41. This comment is made while discussing the various standard test methods. What is the relevance of the sentence? Nowhere in the documents I reviewed, is the mention of untwisting or evidence of any tools used to untwist the yarns. The micrographs presented above (Figure 5) clearly show the absence of any twist in the filling yarns, therefore the question of untwisting is irrelevant.

"To this day, ASTM standard requires manufacturers to count the number of yarns and not the fibers. As explained above, yarns are made from fibers that have been either twisted or laid together and carried across the fabric via the rapier on a loom." [Report, P13]

42. Once again, the comment is immaterial to this discussion. I have not noticed any evidence of counting fibers anywhere. If the fibers were counted the 900 TC Somerset would have

been reported to have 5,520 picks/inch ($69\frac{insertions}{inch} \times 10\frac{picks}{insertion} \times 8\frac{fibers}{pick}$). That is obviously not true.

"They do not include the number of cotton fibers used. Fibers are fibers and yarns are yarns, and if one separates the fibers one no longer has a yarn. Fibers are not counted in the standard, and again AQ is treating the warp different from the filling." [Report, P15-16]

43. Once again, a very confusing and misleading statement. The warp and filling yarns are of different kinds in the subject product. The warp is a staple fiber yarn and the filling yarns are made of continuous filaments (without twist). In both cases, the yarns (see definition earlier) are counted. There is no untwisting involved in either case.

"Q. Tell me again why you don't think you could carry more than one across at a time.
A. Well, it's going to slow down the whole process. It's going to make the production of the bedsheets four, five times longer than what it normally takes.
Q. So if you're inserting -- explain to me how if you're inserting more than one weft yarn at the same time that would be slower than inserting them one at a time?
A. The rapier has to carry the individual yarns across. So the rapier would have to go across 765 times." [Dep, P140]

44. This exchange happens during the discussion on the US patent '790. As explained earlier, the main incentive to insert multiple picks per weaving cycle (or insertion) using the multi-pick technology is to increase the manufacturing speed. The length of fabric produced per unit time can be calculated using the relationship,

$$\left(\frac{length\ of\ fabric\ produced}{min}\right) = \left(\frac{rev}{min}\right) \times \left(\frac{picks\ inserted}{rev}\right) \times \frac{1}{picks/_{inch}}$$

Therefore, more "picks inserted/rev" will increase the manufacturing speed. While the rapier travels 765 times across the loom, it will produce a lot more length of fabric.

"Q. So what is your basis for testifying about what this person is trying to do?
A. Well, it's the –
MR. LEGANDO: Object to form.

A. It's the whole point that I brought up. These guys are not counting yarns. They are counting fibers. You're not allowed to count the fibers. Why are they treating the weft yarns differently than the warp yarns? My report shows, you have fiber industry. You have a yarn industry. You have a fabric industry. Okay. And what we're talking about is counting the yarns, not counting the fibers." [Dep, P 177]

45. Once again, this exchange is not pertinent to any of the documents I have reviewed. Nowhere have I seen evidence of anyone counting fibers. As I pointed out earlier, counting fibers would result in a very large number of threads per inch, well in excess of the represented thread counts.

"Q. Why did customers think that higher thread count is higher quality?
A. As I said, let's take the -- an example of durability. That would be an example of quality.
So, you know, if you take one stick, you're out in the woods, you're a kid. You take one stick, you break. It's easy to break. You go and you break a bunch of sticks, it's much harder to break. So it's more durable. So the more sticks or the more yarns that you would have the more durable the product would be." [Dep. P256]"

46. This is one of the examples of many simplistic and misleading comments made during the deposition. The durability of a bed sheet is not a function of strength alone. What kind of strength (tear, tensile, etc.) is he talking about? And the strength of a fabric is not dependent on the thread count alone. If strength is paramount, bedsheets will be made of glass or Kevlar fibers. The analogy of sticks is misleading is best. What about the strength, dimension, etc. of individual sticks? The design of textiles is complex and it begins with the understanding of the end-use requirements and analysis of the complex interaction of material and structural characteristics. The durability of a bedsheet should depend to a large extent on its ability to survive laundering, abrasion, etc.

VI. <u>Conclusion</u>

47. Based on my review of the materials I have been provided to date, I believe that the contentions in this lawsuit lie in the misunderstanding of fundamental textile technologies and the specific technology used to manufacture the bedsheets. These misunderstandings are reflected in

Cormier's report. In my opinion, based on the weaving methods used by the manufacturer and described in the '790 patent, the appropriate way to measure the thread counts is to count each of the picks inserted into each shed, which Cormier did not do. In my opinion, the thread count on the packaging for the 900 TC Somerset sheets is correct. Also, while I am not aware of any consumer studies to determine what factors might lead a consumer to consider a bedsheet to be superior in quality, it is my opinion that a higher thread count does not necessarily mean a higher quality of a bedsheet.

Dated: May 1, 2021

Tushar K. Ghosh

Tushar Ghosh, Ph.D.

EXHIBIT 1

Tushar K. Ghosh

Professor, College of Textiles, North Carolina State University

EDUCATION

North Carolina State University, Raleigh, NC.
Ph. D., Fiber and Polymer Science (July 1987)

North Carolina State University, Raleigh, NC.
M. S., Textile Materials and Mgmt., Minor: Mathematics (Dec. 1984)

Indian Institute of Technology, New Delhi, India.
M. Tech., Textile Engineering. (July 1978)

University of Calcutta, Calcutta, India
B. Sc. Tech., Textile Technology, (Aug. 1975)

PROFESSIONAL EXPERIENCE

North Carolina State University, Raleigh, NC.

William A. Klopman Distinguished Professor (2018-present), College of Textiles, NC State University
Professor (2008-2018) Textile Engineering, Chemistry, and Science Dept.
Program Director (2008-2012), Textile Technology program
Professor (1999-2008) Textile & Apparel, Technology & Mgmt.
Assoc. Professor (1993-1999) Textile & Apparel, Technology & Mgmt.
Assistant Professor (1992-1993) Textile & Apparel Mgmt.
Visiting Assistant Professor (1987-1992) Textile Eng. & Science
Research Assistant, (1982-1987) Textile Eng. & Science, Teaching Assistant, Mathematics

National Institute of Natural Fiber Engineering & Technology, Calcutta, India.

Scientist (1978-1981) Textile Technology Dept.

Bombay Dyeing & Manufacturing Co. Ltd., Bombay, India

Departmental Assistant (1975-1976) Sulzer Weaving Machinery Dept.

PROFESSIONAL AFFILIATIONS

American Association for the Advancement of Science (AAAS, 2015-present)
IEEE (2018-present)
Fiber Society (1983 – present)
National Parachute Technology Council (1996-1999)
Industrial Fabrics Association International (2001-2008)
SPIE (2001-present)

RESEARCH OVERVIEW

My research interests, while very diverse, maintain a central focus on design, processing, characterization, and application of textile materials and technologies for functional applications. Early in my academic career, I have worked exclusively on the processing, and characterization of textile structures. More recently, most of the research problems I have addressed, alone or in collaboration, have focused on the functional enhancement of textiles at all hierarchical levels by manipulating their fundamental composition and structure. In a pioneering work, we have utilized the concept of bicomponent fibers with dielectric elastomers to develop muscle-like actuating fibers. Other recent works have focused on *(i)* development of electroactive thermoplastic elastomer gels with tunable electromechanical properties, *(ii)* elastomeric nanocomposite as a printed sensory layer on fabrics for strain monitoring, *(iii)* fiber-based multi-modal sensors for biomedical applications, including prosthetic socket inner-environment monitoring, and *(vi)* improving the performance

of rubber synchronous belts. While much of my current research involves responsive polymers, fiber-based sensors and actuators, and nanocomposites, we have recently begun exploring biomimetic soft-robotics systems using carbon nanotube fiber-polymer composites.

INSTRUCTIONAL EXPERIENCE

I have taught a wide range of courses primarily on textile technologies at the graduate and undergraduate levels including Mechanics of Fibrous Assemblies, Design and Analysis of Technical Textiles, Performance Evaluation of Textiles, Woven Fabrics & Technology. I am genuinely passionate about teaching and I believe that teaching is a great privilege and an incredibly rewarding responsibility.

AWARDS & HONORS

Illustration featured on the cover of the Advanced Functional Materials (2018)

Board of Governors Award for Excellence in Teaching, 2012-13, Nominee, College of Textiles

Illustration featured on the cover of the Journal of Polymer Science |Part B, Polymer Physics (2011)

Invited Lecturer to Summer School, Donghua University, 2012-2018

Editorial Board, Journal of the Textile Institute (2001-present)

Editorial Board, Textile Research Journal (2005-2016)

Editorial Board, Journal of Fiber Bioengineering and Informatics (2008-2016)

Pride of the Dept. Award, Textile Tech. Dept., Indian Institute of Technology, Delhi, India, 2009

Illustration featured on the cover of the Advanced Materials (2007)

Founders Award, Fiber Society, 2007

National Textile Center, Circle of Excellence, 2005

College of Textiles Outstanding Teaching Award; inducted into the NCSU Academy of Outstanding Teachers (1995-96)

Visiting Scholar, School of Mathematics and Statistics, University of Sydney, 1993

SCHOLARLY PEER REVIEW ACTIVITIES

Reviewed research proposals for: The National Science Foundation (NSF)-USA, Research Grants Council (RGC) of Hong Kong, National Research Foundation of Korea, KAIST, American Association for the Advancement of Science (AAAS), and others.

Ad hoc reviewer for: Nature, Science, Advanced Materials, Advanced Functional Materials, Sensors and Actuators A & B, Carbon, Small, Textile Research Journal, Journal of the Textile Institute, and others.

STUDENT AWARDS & HONORS

Talha Agcayazi: Placed second in the poster session FLEX conference (2018)
A. Kapoor: Poster Award, Textiles Res. Day, College of Textiles, NCSU *Most Innovative Research Poster* (2017)
A. Krishnan: Poster award winner. Materials Res. Society National Meeting, Boston, MA, November (2010)
A. Krishnan: 1st place, 5th annual NCSU Graduate Student Research Symposium (2010)
P. Vargantwar: 3rd Place (tied), Chemical & Biomolecular Engineering Schoenborn Poster Competition (2010)
Ravi Shankar: Finalist and silver medalist, MRS Graduate Student Award, 20007
Ravi Shankar: 1st Place, Richard D. Gilbert Award in Polymer Science (2007)
X. Y. Sun, R. Shankar: Best Overall Prize, Poster Competition, 15th Annual National Textiles Center Forum (2007)

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- **Boston University,** Prof. David Holmes, Mechanical Engineering Dept.,
- **Tampere University of Technology**, Finland: Prof. Heikki Mattila, Professor, Textile and clothing production technology**,**
- **University of Sydney,** Australia: Prof. Barrie Fraser, Emeritus Professor, Department of Applied Mathematics.
- **Max-Planck Institute,** Potsdam, Germany : Dr. Hans Börner, , Group Leader, Colloids & Surfaces,
- **Indian Institute of Technology, Delhi, India:** Prof. Anuj Dhawan, Assistant Professor, Department of Electrical Engineering.

Scholarly Contributions

Peer-Reviewed Publications

1. Tabor, J., Agcayazi, T., Fleming, A., Thompson, B., Kapoor, A., Liu, M., … Ghosh, T. K. (2021). Textile-Based Pressure Sensors for Monitoring Prosthetic-Socket Interfaces. IEEE Sensors Journal, 21(7), 9413–9422. https://doi.org/10.1109/JSEN.2021.3053434

2. Tabor, J., Chatterjee, K., & Ghosh, T. K. (2020). Smart Textile-Based Personal Thermal Comfort Systems: Current Status and Potential Solutions. Advanced Materials Technologies, 3, 1901155. https://doi.org/10.1002/admt.201901155

3. Chatterjee, K., Negi, A., Kim, K., Liu, J., & Ghosh, T. K. (2020). In-Plane Thermoelectric Properties of Flexible and Room-Temperature-Doped Carbon Nanotube Films. ACS Applied Energy Materials, 7. https://doi.org/10.1021/acsaem.0c00995

4. Agcayazi, T., Tabor, J., McKnight, M., Martin, I., Ghosh, T. K., & Bozkurt, A. (2020). Fully-Textile Seam-Line Sensors for Facile Textile Integration and Tunable Multi-Modal Sensing of Pressure, Humidity, and Wetness. Advanced Materials Technologies, 6, 2000155.

5. Chatterjee, K., & Ghosh, T. K. 3D Printing of Textiles: Potential Roadmap to Printing with Fibers. *Advanced Materials* 32 (2020).

6. Armstrong,D. P., Chatterjee, K., Ghosh, T. K., & Spontak, R.J., Form-stable phase-change elastomer gels derived from thermoplastic elastomer copolyesters swollen with fatty acids, *Thermochimica Acta* 686 (2020) 178566

7. Wei, S., Shao, H., & Ghosh, T. K. (2019). Bioinspired Bistable Soft Actuators. ELECTROACTIVE POLYMER ACTUATORS AND DEVICES (EAPAD) XXI. https://doi.org/10.1117/12.2522123

8. Chatterjee, K., Tabor, J., & Ghosh, T. K. (2019). [Review of Electrically Conductive Coatings for Fiber-Based E-Textiles]. FIBERS, 7(6). https://doi.org/10.3390/fib706005

9. White R, McKnight M, Agcayazi T, Tabor J, Ghosh T, Bozkurt A. (2018). A Wetness Detection Technique Towards Scalable, Array-Based, Fully-Textile Sensing. 2018 IEEE Biomedical Circuits and Systems (BioCAS), 1-4, DOI. 10.1109/BIOCAS.2018.8584799.

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10. McKnight M, Tabor J, Agcayazi T, Fleming A, Ghosh T, Huang H, Bozkurt A., Fully-textile Insole Seam-line for Multi-modal Sensor Mapping. IEEE Sensors Journal.

11. Kapoor, A., McKnight, M., Chatterjee, K., Agcayazi, T., Kausche, H., Bozkurt, A., & Ghosh, T. K. Toward Fully Manufacturable, Fiber Assembly–Based Concurrent Multimodal and Multifunctional Sensors for e-Textiles. *Advanced Materials Technologies*, 1800281(2018).

12. Shao, H., Wei, S., Jiang, X., Holmes, D. P. & Ghosh, T. K. Bistable Polymer Actuators: Bioinspired Electrically Activated Soft Bistable Actuators (Adv. Funct. Mater. 35/2018). *Advanced Functional Materials* **28** (2018).

13. Jiang, X., Pezzulla, M., Shao, H., Ghosh, T. K. & Holmes, D. P. Snapping of bistable, prestressed cylindrical shells. *EPL (Europhysics Letters)* **122**, 64003 (2018).

14. Agcayazi, T., Chatterjee, K., Bozkurt, A. & Ghosh, T. K. Flexible Interconnects for Electronic Textiles. *Advanced Materials Technologies*, 1700277 (2018).

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28. Subramani, K. B., Cakmak, E., Spontak, R. J. & Ghosh, T. K. Enhanced Electroactive Response of Unidirectional Elastomeric Composites with High-Dielectric-Constant Fibers. *Advanced Materials* **26**, 2949-2953 (2014).

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4. Topracki, H. A. K. & Ghosh, T. K. in *Handbook of Smart Textiles* (ed Tao, X.) (Springer Singapore, Singapore, 2015).
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6. Ghosh, T. & Chhaparwal, S. in *Handbook of Nanoscience, Engineering, and Technology* (eds Goddard-III, W. A., Brenner, D. W., Lyshveski, S. E. & Iafrate, G. J.) 21.43 (CRC Press, Taylor & Francis Group, Boca Raton, FL, 2007).

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7. Ghosh, T. & Dhawan, A. in *Indian Journal of Fiber & Textile Research: Special Issue on Emerging Trends in Polymers and Textiles* (eds Chattopadhyay, R. & Jassal, M.) 170-176 (National Institute of Science and Communication Information Resources, CSIR, New Delhi, India, 2006).
8. Dhawan, A., Ghosh, T. K. & Seyam, A. Fiber-Based Electrical and Optical Devices and Systems. *Textile Progress* **36**, 1-84 (2004).
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1. McKnight, M., Agcayazi, T., Ghosh, T. K. & Bozkurt, A. *Modeling and Characterization of Multi-modal Sensing Fibers* (Flexible Electronics Conference and Exhibition - 2018FLEX, Flex 2018, Monterey, CA, February 2018).
2. Spontak, R. J., Subramani, K. B., Armstrong, D. P., Cakmak, E. & Ghosh, T. K. *Fabrication strategies for exploring the anisotropic electroactuation of dielectric elastomers (Conference Presentation)* (SPIE Smart Structures + Nondestructive Evaluation Ser. 9798, SPIE, Las Vegas, USA, Apr 15, 2016).
3. Vargantwar, P., Ghosh, T. K. & Spontak, R. J. *Ionic actuators derived from selectively solvated block copolymers* (SPIE Smart Structures + Nondestructive Evaluation, SPIE, San Diego, CA, USA, March 2011).
4. Dhawan, A., Ghosh, T. K. & Muth, J. F. *Incorporating Optical Fiber-based Sensors into Fabrics* (Materials Research Society Conference, Materials Research Society, Boston, MA, February 1, 2011).
5. Di Spigna, N. et al. *The integration of novel EAP-based Braille cells for use in a refreshable tactile display* (SPIE Smart Structures and Materials + Nondestructive Evaluation and Health Monitoring Ser. 7642, SPIE, San Diego, CA, USA, Apr 8, 2010).
6. Di Spigna, N., Chakraborti, P., Yang, P., Ghosh, T. & Franzon, P. *Application of EAP materials toward a refreshable Braille display* (SPIE Smart Structures and Materials + Nondestructive Evaluation and Health Monitoring, Ser. 7287, SPIE, San Diego, California, USA, Mar 26, 2009).
7. Vargantwar, P. H., Ghosh, T. K. & Spontak, R. J. *Novel thermoplastic elastomeric gels as high-performance actuators with no mechanical pre-strain* (SPIE Smart Structures and Materials + Nondestructive Evaluation and Health Monitoring, 2009 Ser. 7287, SPIE, San Diego, CA, USA, Mar 26, 2009).
8. Karahan, A., Vargantwar, P., Spontak, R. J. & Ghosh, T. K. *Carbon Nanofiber Modified PVC as Fabric Sensor Composite for E-Textiles* (NSF-CMMI Research and Innovation Conference, NSF-CMMI, Honolulu, 2009).
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10. Shankar, R., Ghosh, T. K. & Spontak, R. J. *Intriguing electroactive behavior of nanostructured polymers* (SPIE Smart Structures and Materials and NDE for Health Monitoring and Diagnostics, SPIE, San Diego, CA, USA, 2007).

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11. Shankar, R., Ghosh, T. K. & Spontak, R. J. *Electromechanical Response of Nanostructured Polymer at Zero Prestrain* (SPIE Smart Structures and Materials and NDE for Health Monitoring and Diagnostics, SPIE, San Diego, CA, USA, 2007).
12. Sun, X., Shankar, R., Ghosh, T., Borner, H. G. & Spontak, R. *Field-Driven Surface Biofunctionalization of Electrospun Fibers*(2006 AIChE Annual Meeting, AIChE, San Francisco, CA, November 2006).
13. Ghosh, T. K., Arora, S. & Muth, J. *Fiber Actuators* (International Fiber Conference 2006, The Fiber Society, Seoul, Korea, 2006).
14. Dhawan, A., Muth, J. F., Kekas, D. J. & Ghosh, T. K. *Optical nano-textile sensors based on the incorporation of semiconducting and metallic nanoparticles into optical fibers* (Materials Research Society Conference Symposium S Ser. 920, Cambridge University Press, Boston, MA, 2006).
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22. Natarajan, K., Dhawan, A., Seyam, A. M., Ghosh, T. K. & Muth, J. F. *Electrotextiles - Present and Future* (Materials Research Society Conference Ser. 736, Cambridge University Press, Boston, MA, Jan 1, 2002).
23. Dhawan, A., Ghosh, T. K., Seyam, A. M. & Muth, J. *Development of Woven Fabric-based Electrical Circuits (Invited)* (Materials Research Society Conference Ser. 736, Cambridge University Press, Boston, MA, Jan 1, 2002).
24. Muth, J. F. et al. *Signal Propagation and Multiplexing Challenges in Electronic Textiles (Invited)* (Materials Research Society Conference Ser. 736, Cambridge University Press, Boston, MA, USA, Jan 1, 2002).
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27. Batra, S. K., Ghosh, T. K. & Zeng, Q. *Dynamic Analysis of Ring Spinning: A Brief Review* (Textile Science Conference, Liberec, Czech Republic, 2000).

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28. Huang, W. &Ghosh, T. K. *Instrumentation of Online Monitoring System for Fabric Compressional Behavior* (International Instrumentation Symposium, Seattle, 2000).
29. Huang, W. &Ghosh, T. K. *Application of Filters in Textile Industry and Fibrous Filters* (Filtration and Separations Technologies, AFS Society, Northport, AL, 2000).
30. Wensheng Huang &Ghosh, T. K. *Online measurement of fabric mechanical properties: compressional behavior* (IEEE Industry Committee Conference, IEEE, Atlanta, USA, 1999).
31. Ghosh, T. K. *Development of an Instrument for the Evaluation of Biaxial Stress-Strain Response of Fabrics* (Association of the Nonwoven Fabric Industry, INDA-TEC, Cary, NC, USA, 1998).
32. Batra, S. K., Ghosh, T. K. & Zeidman, M. I. *On the Dynamic Analysis of Ring Spinning*, Wool Research Organization of New Zealand and the Textile Institute, New Zealand, New Zealand, 1988).

Patents Issued

1. Smart Textile Sensing Systems and related Methods, U.S. patent **20170224280**, Bozkurt, A., Ghosh, T., McKnight, M., Issued: August 10, 2017
2. Electroactive Nanostructured Polymers as Tunable Organic Actuators, U.S. patent **7,956,520**, Shankar, R., Ghosh, T. K., Spontak, R. J., Issued: June 7, 2011
3. Fabric and Yarn Structures to Improve Signal Integrity in Fabric-based Electrical Circuits, U. S. patent **7,348,285** B2, Dhawan, A., Ghosh, T. K., Seyam, A. M., and Muth, J. F., Issued: March 25, 2008
4. Methods and Systems for Selectively Connecting and Disconnecting Conductors in a Fabric, U. S. patent **7,329,323** B2, Dhawan, A., Ghosh, T. K., Seyam, A. M., and Muth, J. F., Issued: February 12, 2008
5. Methods and Systems for Selectively Connecting and Disconnecting Conductors in a Fabric, U. S. patent **6,852,395**, Dhawan, A., Ghosh, T. K., Seyam, A. M., and Muth, J. F., Issued: February 8, 2005
6. Apparatus and method for biaxial tensile testing of membrane materials, U. S. patent **6,487,902,** Ghosh, T. K., Issued: December 3, 2002.

Technical Presentations at Conferences and Symposia

More than 200 presentations in national and international conferences, including more than 60 invited and keynote lectures.

Consulting Activities

Albany International Co., Lorex Corporation, Lear Seating Co. United Nations Development Program, 3M Corporation, General Motors Corporation, Sara Lee Corporation, Tsudakoma Corporation, North Sails Corporation, Yupoong, Inc., TRW Corp., Monmouth University, Touch Materials

ADVISORY ACTIVITIES

Academic advising

Formally advised numerous Textile Technology, and Textile and Apparel Management undergraduates.

Informally advised many Textile Technology, Textile and Apparel Management, Textile Engineering, Materials Science and Engineering, and Chemical Engineering graduate students on matters regarding research opportunities, available/upcoming courses and professional development.

Research Advising:

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Post-Doctoral Research Associates/Visiting Scholars Directed/Hosted

1991-1993	Dr. Hong Peng, Mechanics of Textile Structures
1994-1996	Dr. Zengheng Xie, Biaxial Tensile Behavior of Fabrics
1995-1996	Dr. Sanat Bandopadhyay, Characterization of Fabrics
1994-1995	Dr. Anup Bandopadhyay, Yarn Quality Characterization
1997-1998	Dr. Tae Young Park, Characterization of Geotextiles
1997 - 2000	Mr. A. Deshpande, Dynamic Analysis of Ring Spinning Balloon
2015- 2017	Mr. Huiqi Shao, Bisatable/Morphing EAP Devices

Doctoral Research Directed

Qingyu. Zeng (1995), Owens Corning S & T, Granville, OH, Nayiue Zhou (1996), Corning, Inc, NY, Ma Xiaofeng (1997), Breed Technologies Inc., TN, Harsha Puneetha (1997), Bayer Corp., NC, Christian Koch (1999), Raoul Farer (1999), Freduenberg Nonwovens, Germany, Wensheng Huang (1999), Ericsson Telecommunications, NC, Pan Zicheng (2001), Syncsort, Inc., NJ, Kristie Phillips (2002), Cotton Inc., NC, Anuj Dhawan (2006), Indian Institute of Technology, New Delhi, Jeesang Huang (2006), Samsung SDI Co. Ltd., Seoul, Ravi Shankar (2007), Intel Corp., AZ, Pruthesh Varganttwar (2009) Eastman Chemicals, TN, Saral Kalandhabhatla (2013) University of Rhode Island, Aylin Karahan Toprakci (2013), Yalova University, Turkey, Krishna Bala Subramani (2014), Enes Cakmak (2014), Suleyman Demirel University, Turkey, Xiaomeng Fang (2017), NC State University, Ashish Kapoor (2020), Intel Corp., Kony Chatterjee (Current), Jordan Tabor (current), Shuzhen Wei (Current)

Masters Research Directed

Bhupesh Dua (1991), Nike Inc. Hua Li (1989), Deying Kong (1992), Xi Qiao (1994), Prudential Investments, Sachin Parker (1994), Anuj Jain (1995), M. V. Rao (1993), Ana Leiderman (1996), A. S. Murthy (1994), Ford Motor Co., MI, Hemen Dattani (1997), Co-major IMSE, Surya Gupta (1998), Du Pont Co., Karthikeyan Natarajan (2002), The Limited, NY, Anuj Dhawan (2002), Duke University, NC, Cuneyt Akbay (2003), Nnao-Tex LLC, Istanbul, Sohil Arora (2004), Select Comfort, CO, Saurabh Chaaparwal (2004), Freduenberg Nonwovens, NC, Parthasarathi Chakraborti (2012), Georgia Institute of Technology, Shuzhen Wei (2018), Samantha Jeffrey (2018),

Graduate Student Committees

Served in numerous graduate student committees at both Ph. D. and M.S. levels.

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EXHIBIT 2

List of Documents Reviewed

AQ-HawesVMacys_0005349
AQ-HawesVMacys_0005393
AQ-HawesVMacys_0005411
AQ-HawesVMacys_0005419
AQ-HawesVMacys_0005482
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AQ-HawesVMacys_0022019
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MACYS_0000760
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Deposition Transcript of Sara Hawes w/ Exhibits
Deposition Transcript of Larry Queen w/ Exhibits
Deposition Transcript of Sean Cormier w/ Exhibits
Report of Sean Cormier
Photographs produced by Sean Cormier
Third Amended Complaint